Estimating maximum available soil water depending on the sugarcane root system for a deficit irrigation adjustment

CHOPART JL[1], LE MEZO L[2]

[1]*Consultant, AGERconsult, Montpellier, France,* [2]*CIRAD, UR AIDA, La Réunion, France*

E-mail: jl.chopart@orange.fr

Abstract

We present the findings of a study testing the PRER (Potential Root Extraction Ratio) model (Leifi *et al.*, 2011) to estimate the maximum available soil water (MASW) depending on the sugarcane root system in a deep soil of La Reunion. The aim is to optimize sugarcane irrigation, especially deficit irrigation (DI), by adjusting irrigation rates and intervals according to root distribution in the soil.

The experiment was conducted in a deep Cambisol in La Reunion. Sugarcane cultivar was R570. Measurements where done in a ratoon crop nine months after harvest of the previous crop. Root spatial distribution was studied using the trench-profile method by counting and mapping root intersections (RI) in four soil profiles to a depth of four metres using a grid with a 5 x 5 cm mesh. From RI, we inferred root length densities (RLD) (Chopart *et al*., 2008) and root distances (RD) (Newman, 1969).The PRER (%) is the ratio of volume of soil potentially accessible to a root for water uptake (Vu) and the whole volume of soil assigned to that root (Vt). Modelling of Vu took RD into account as well as a maximum distance of water movement from soil to roots (5 cm). The conventional maximum available soil water (MASWlab) was measured at several depths. It had a uniform value of 0.1cm/cm from the soil surface to the four metre depth.

The results revealed a wide variability in root distribution between the soil surface and the rooting front (4 m), with many competing roots and rootless zones. PRER values ranged from 80% near the surface to values ranging from 30% to 1% between the 1 – 3 m depth. From PRER and MASWlab, we estimated a biological MASW (MASWbiol) depending on root distribution in the soil. MASWbiol ranged from 0.8 mm/cm near the surface to 0.4 mm/cm at 1 m, and 0.01 mm/cm at 3 m. Total MASWbiol was 86 mm (stand. dev.: 14) and 88 mm for the 3 and 4 m rooting depths respectively. When only rooting depth and MASWlab/cm were used, values of total MASWlab ranged from 300 mm to 400 mm for the 3 – 4 m depth interval.

There was a marked difference between conventional MASWlab and MASWbiol calculated from root mapping and PRER modelling. MASWbiol appeared to provide a better estimate than conventional MASWlab for crop modelling and irrigation, especially for DI. Importantly, DI requires a good estimate of how long it takes the soil water storage to be depleted to the maximum allowable value.

Results showed the need to consider rooting depth and root spatial distribution in deep sugarcane-producing soils of La Reunion. This could also be applicable in places like Brazil, where sugarcane rooting depth may reach 4 m (Chopart *et al*, 2010) or beyond (Laclau and Laclau, 2009), or for soils with physical constraints where root distribution is very irregular.

Keywords: rooting spatial distribution, root length density, potential root extraction ratio